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Public outreach for the EC Carbon-14 Source Term project

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Carbon-14 is a radionuclide present in some waste destined for disposal. It can be released in a gaseous form and non-ionic liquid form during waste degradation, and consequently waste-derived carbon-14 can be one of the radionuclides that can reach our atmosphere first following disposal activities. The EC Carbon-14 Source Term (CAST) project aimed to develop understanding of the potential release mechanisms of carbon-14 from wastes containing this radionuclide, under conditions relevant for waste packaging and disposal to underground geological disposal facilities. Newsletters have been written to disseminate the knowledge developed in CAST to an audience with no knowledge in radiation protection and unfamiliar with radioactive waste. The schedule of the publication of CAST reports, which was defined at the start of the project, was used to determine the topics to be treated in the newsletters. Four newsletters contained an example of an analogue associated with carbon-14, in order to familiarise the reader with the topic. An analogue is understood here as a description of the same processes taking place in natural systems and in pure or partly artificial systems such as geological disposal of radioactive waste. The only differences between both systems can be different parameter values to calculate process rates.

In the first two newsletters, it was explained that natural and artificial carbon-14 is mainly generated by neutron activation of nitrogen. The similarities and differences in the parameter values were detailed. Examples of calculated carbon-14 contents of samples of waste used in CAST were compared with the clearance level according to the latest Directive 2013/59/EURATOM, which lays down basic safety standards for protection against the dangers from exposure to ionising radiation, to show when hazardous amounts of carbon-14 can be present in waste.

In the most recent two newsletters, the release of incorporated natural carbon-14 in plants and trees was compared with the potential release of carbon-14 from the waste. Any organic carbon species released from the waste will be converted into $^{14}CO_2$ by microbes before this artificial carbon-14 reaches our atmosphere. The maximum carbon-14 source term considered in CAST was determined for neutron irradiated steel, for which chemical corrosion was used as a release mechanism in disposal-relevant conditions. At the start of disposal, if steel is encapsulated in cementitious material, the carbon-14 release rate from this waste-form was determined to be 100 times larger than the minimum in the carbon-14 natural emanation rate from soil. The geological disposal facility host rock and surrounding geology would reduce the carbon-14 flux by dilution, diffusion and dispersion, from the point of waste to subsequent surface discharge, by a factor of at least 10^7 to a level significantly below the natural $^{14}CO_2$ release rate from soil.

A manuscript explaining in more detail the exposure from artificial and cosmogenic carbon-14 has been written for the broad scientific community and has recently been accepted for publication by the Journal: Radiocarbon.

References: https://www.projectcast.eu; https://www.cambridge.org/core/journals/radiocarbon.